APPLICANT ARGUMENTS OR REMARKS

Claims 11 – 64 are now in the application. Claims 11- 14, 16, 18-22, 29, 32-34, 41 and 50 are amended. Claims 11 and 41 are independent claims. Claims 51 – 64 are newly presented.

Order of remarks

The Office Action has elements, each of which is addressed below. The rejections of independent claims 11 and 41 are addressed first, as by argument and amendment, applicant submits that these are now in condition for allowance.

Claim Rejection under 35 U.S.C. 103(a)

The Office Action rejects claims 11 and 41 as obvious over Payne (U.S. Patent application 2004/0263930) in view of someone of ordinary skill in the art and the inherent properties of elements.

Payne does not disclose "the optical system generating a Fourier or inverse Fourier transform reconstruction of the hologram encoded on the hologram-bearing medium at the image plane of the light source…".

Instead, in Payne, it is the holographic reconstruction representing the three-dimensional scene that is at the image plane of the light source, and not just the Fourier transform of the hologram. See Payne: "A 3D image 6 appears to the viewer to be located in the image/Fourier plane of the replay optics" [0009]. So Claim 11 requires a step that Payne explicitly teaches away from.

Nor does Payne disclose "providing a viewing window in the image plane of the light source, the viewing window being the location where an observer places at least one eye to view the holographic reconstruction representing the three-dimensional scene, the size of the viewing window being no larger than a single diffraction order of the light diffracted by the hologram-bearing medium"

Instead, in Payne, the observer never places his eye at the image plane of the light source, since that is where the 3D reconstruction arises. So in Payne, there is no concept of there being

a viewing window *at the image plane of the light source*, where an observer places at least one eye to view the holographic reconstruction representing the three-dimensional scene.

Nor does Payne disclose "encoding the hologram on the hologram-bearing medium to reconstruct a given object point, when seen from the viewing window, in only a *limited* region of the hologram-bearing medium". The examiner is asked to consider recently allowed Application Number 11/427,640 on this point; the relevance is discussed in the final section of this reply, headed 'Additional Comments'. In conventional holography, the encoding needed to reconstruct a given object point is distributed across the *entire* hologram-bearing medium. There is no suggestion in Payne that it departs from this standard approach.

Applicant, therefore, requests that this rejection be withdrawn and independent claims 11 and 41 be allowed.

As dependent claims 12 – 40, 42 - 48 and 50 now depend from, and include all the limitations of, an allowable claim, they are also in condition for allowance.

Applicant, therefore, requests that this rejection be withdrawn and claims 12 – 40, 42-48 and 50 be allowed.

Claim Rejection under 35 U.S.C. 102

The Office Action rejects independent claims 49 as anticipated by Payne (U.S. Patent application 2004/0263930).

Claim 49 has been deleted.

We will now address the examiner's rejections and objections in the order they appear in the Office Action.

Claim Rejection under 35 USC 132(a)

The Claim 11 term "virtual observer window" in Claims 11, 41, 49 is objected to by the examiner under 35 USC 132(a) as not supported by the original disclosure. Applicant believes that it would be apparent to the skilled implementer that a 'viewing window' (i.e. the original phrase) is exactly the same as a 'virtual observer window', that there is therefore no inadmissible new matter, and that the latter term is useful since it aids conceptual understanding. However, in the amended claims presented with this response, the term is amended back to the original

phrase "viewing window".

In each instance of its occurrence in the Claims (i.e. in Claims 11, 12, 13, 14, 18, 19, 20, 21, 22, 29, 32, 33, 34, 41, 49) 'virtual observer window' has been replaced by the original term, 'viewing window'.

The Claim 11 phrase: "the pitch of the spatial light modulator determining the maximum size of the virtual observer window and not the maximum size of the holographic reconstruction" has been objected to. This phrase has now been deleted.

The Claim 41 phrases: "a computational unit controlling the spatial light modulator … so that the wavefront is associated with a virtual observer window.." "the computational unit is operable to limit the size of the virtual observer window to be no larger than a single diffraction order" have been objected to. These phrases have now been deleted.

The Claim 49 phrase: "a computational unit adapted to control the way in which a hologram is encoded on a spatial light modulator" has been objected to. Claim 49 has now been deleted.

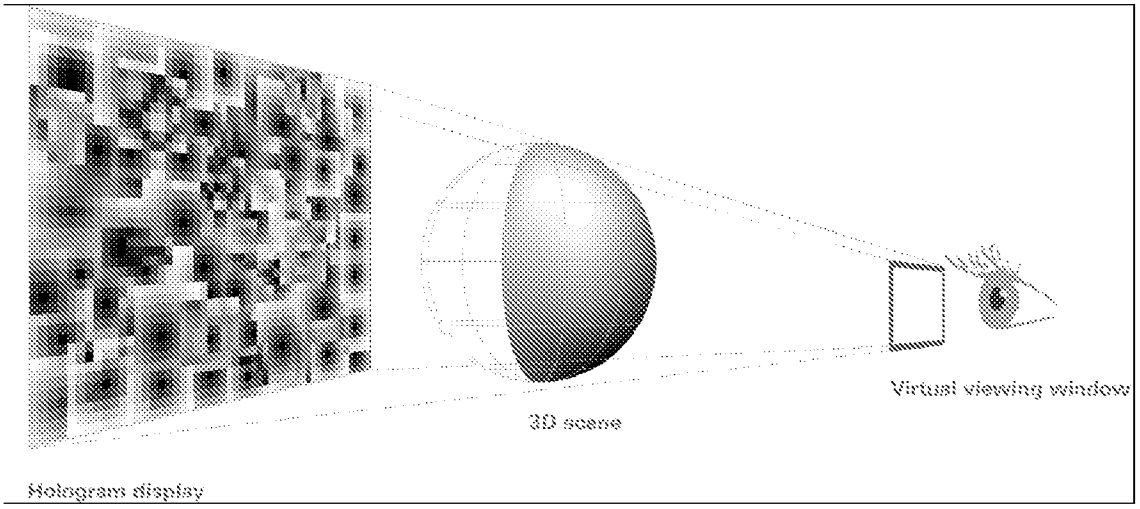
Claim Rejection under 35 U.S.C. 112, first paragraph.

The Office Action rejects claim 11-50 under 35 U.S.C. 112, first paragraph, stating that the specification fails to comply with the written description requirement. The amendments listed above address the rejections under 35 USC 112 first paragraph.

Claim Rejection under 35 U.S.C. 112, first paragraph.

The Office Action rejects claim 11-50 under 35 U.S.C. 112, first paragraph, stating that the specification fails to provide support or enablement for various claim elements.

The Examiner states that the specification fails to provide the enablement of creating a 'virtual observer window'. The skilled implementer will appreciate that the 'viewing window' (or indeed a 'virtual observer window') is simply a region in space through which the reconstructed object is visible. There is no physical structure there:



The observer merely places his eye at the viewing window and looks through it. In the illustration above, the only physical items are the display device and the observer. So it as just like any other kind of optics system in which an observer has, for optimal viewing, to place his eyes at a certain position, e.g. at the eyepiece of a microscope. The specification makes it clear that this viewing window is simply a region in space in which the wavefronts are the direct or inverse Fourier transform of the video hologram that is present on the hologram-bearing medium. Generating a wavefront that is a direct or inverse Fourier transform of a hologram that is present on the hologram-bearing medium is a standard technique in holography and is, for exampled, discussed in the primary citation US 2004/0263930:

> "A commonly used method of displaying a HPO CGH is to use a cylindrical lens combined with a conventional (e.g. spherical) lens such that an image of the hologram is formed in the vertical direction and its Fourier transform (i.e. that contains information about a horizontal slice through the 3-dimensional image) is formed in the horizontal direction. [para 0006].

The examiner is asked to consider recently allowed Application Number 11/427,640 on this point; the relevance is discussed in the final section of this reply, headed 'Additional Comments'.

The examiner considers also that the specification fails to provide enablement that "the holographic reconstruction is described by the Fresnel transform of the hologram and not the Fourier transform of the hologram" Claim 16. This is enabled because if the wavefront at the viewing window is the Fourier transform of the hologram (as can be achieved with conventional optics – see US 2004/0263930 Payne), then the wavefronts between the hologram bearing

medium and the viewing window – for example the circle in Figures 2 and 3 of this application - can inevitably be described by the Fresnel transform of the hologram. This is simply a feature of any optical system because of the theory of optics: the Fresnel transform is a general form of the Fourier transform and at the image plane, the Fresnel transform can be described by the simpler a Fourier transform, but elsewhere the full Fresnel transform is needed.

The examiner states that the specification fails to disclose how the image plane of the light source is generated, adding that a spatial light modulator will not generate an image plane. Paragraph [0001] of the specification reads:

> [0001] The present invention relates to a video hologram and a device for reconstructing video holograms comprising an optical system, that consists of at least one light source, a lens and a hologram-bearing medium composed of cells arranged in a matrix or an otherwise regular pattern with at least one opening per cell, the phase or amplitude of said opening being controllable, and a viewing plane located in the image plane of the light source.

One skilled in the art will understand from this paragraph and independently from elsewhere in the specification that it is the lens which generates the image plane of the light source. Furthermore, a lens is labeled as "2" in Figures 1, 2, 3 and 5.

The examiner objects that "The specification fails to disclose how does the virtual light source is generated." Virtual light sources are well known in the art and are for instance achieved by using a mirror: the virtual light source is then the reflection of the real light source. Figures 6, 7 and 9 also show virtual light sources. The Figures are described in their respective figure captions. The method of generating virtual light sources will be clear to one skilled in the art from these Figures, their captions, from the specification, and from common general knowledge.

The examiner objects that "The specification fails to disclose how the light source is positioned by the mechanical or electronic displacement or by movable mirrors." The method of positioning virtual light sources by the mechanical or electronic displacement or by movable mirrors will be apparent to one skilled in the art from these Figures, their captions, from the specification, and from common general knowledge. Further, Figures 6, 7 and 9 show virtual light sources. The Figures are described in their respective figure captions.

The examiner states that "The specification fails to disclose how does the computational unit is capable of limiting the size of the virtual observer window." The operation of the computational unit has been removed from the amended claims to address this objection.

Objections under 35 USC 112 second paragraph

The examiner rejects Claim 50 under 35 USC 112, second paragraph. In response, Claim 50 has been revised to be dependent on Claim 41.

Claim objections

The examiner raises a number of objections based on various informalities.

(1) Regarding "image plane of the light source", please read paragraph [0001] of the specification. One skilled in the art will understand from this paragraph in the specification that it is the lens which generates the image plane of the light source. Furthermore, a lens is labeled as "2" in Figures 1, 2, 3 and 5. Regarding "the maximum size of the holographic reconstruction", this phrase has been removed from Claim 11 and Claim 41.

(2) The term "reconstruction volume" in Claims 11 and 41 is no longer used. Instead, we specify "forming the holographic reconstruction within a reconstruction frustum stretching between the hologram-bearing medium and the viewing window". This derives from:
"The scene is thus located inside the reconstruction frustum which stretches between the hologram-bearing medium 3 and the viewing window 5." [0014] It in essence is the volume within which it is possible for a reconstructed object to be seen.

(3) In Claim 13, the region is a small portion of the hologram on the hologram-bearing medium (for example, on current prototypes, it is a region about 1 – 2 cm^2 on the SLM). It corresponds to the 'projection area' as described in the following text:

> "A pyramid with the viewing window 5 being the base and the selected point 7 in the scene 6 being the peak, is prolonged through this point and projected on to the hologram-bearing medium 3. A projection area 8 is created in the hologram-bearing medium 3 that point being holographically encoded in said projection area. The distances between the point 7 to the cells of the hologram-bearing medium 3 can be determined in order to calculate the phase values. This reconstruction allows the size of the viewing window 5 to be constrained by the periodicity interval. If, however, the point

7 was encoded in the entire hologram-bearing medium 3, the reconstruction would extend beyond the periodicity interval." [0034]

This text also makes it clear that each point in a reconstruction is not encoded across the entire hologram (as is usually the case) but is instead restricted to a specific region. The examiner is asked to consider recently allowed Application Number 11/427,640 on this point; the relevance is discussed in the final section of this reply, headed 'Additional Comments'.

(4) See above.

(5) Claims 16 and 17 deal with very different things and do not contradict each other. Claim 16 defines the holographic reconstruction as the Fresnel (but not Fourier) transform of the hologram. Claim 17 states that a Fourier transform of the hologram is generated at the image plane. The apparent contradiction is resolved because it is a unique and fundamental aspect of this invention that the holographic reconstruction is not designed to occur at the image plane: hence Claim 16 and 17 are not in conflict.

(6) The phrase "the virtual observer window is smaller that the hologram-bearing medium" must mean that the size (e.g. area) of the entire observer window is smaller than the size of the entire hologram-bearing medium. It would not be possible for an observer window, through which an observer must look in order to see the reconstruction, to be smaller than the pitch of the SLM since the pitch will be measured typically in microns – far too small to look through.

(7) In a search of the claims of US patents granted since 1976 using the USPTO online database, the phrase "and/or" was identified in the claims of 138,687 (one hundred and thirty eight thousand six hundred and eighty seven) patents. At least 50 of these patents were granted on the single day November 6th 2007. Therefore allowing this phrase in patent claims appears to be consistent with present day USPTO practice.

(8) In response, Claim 50 has been revised to be dependent on Claim 11.

Additional Argument

We note that the USPTO has recently issued US 7,315,408, a divisional application from the present, parent application. In the light of that allowance, it would seem that further objections to the revised Claims submitted herein may constitute an inconsistency on the part of the USPTO. Examiner is respectfully requested to refer to the file for US 7,315,408 (US Application Number 11/427,640), and to consider its contents when examining the revised Claims now submitted, in particular the comments about allowable subject matter on page 8 of

the Office Action dated January 16th 2007 for US Application Number 11/427,640. For the examiner's convenience, these comments are reproduced below.

> "Allowable Subject Matter
>
> Claim 3 is allowable over the prior art of record for at least the reason that even though the prior art discloses a holographic display system, wherein a three dimensional image can be seen within a volume defined by the view field as seen through a virtual observer window, the prior art fails to teach or reasonably suggest, a display device for video holography, wherein the region producing a point being visible from a defined viewing position is restricted in size to form a portion of the entire hologram, the size being such that multiple reconstructions of that point caused by higher diffraction orders are not visible at the defined viewing position, as set forth by the claimed combination.
>
> Kitamura (US 7,068,403, Fig. 1), which is not prior art, discloses a method for designing a computer generated hologram ("CGH"), wherein the CGH comprises multiple regions/cells, each region/cell reconstructing a single point of the object. However, Kitamura does not teach the creation of virtual observer windows, through which the three dimensional recreation of the object can be seen, or the effect of the cross-talk noise due to higher diffraction orders."

The Claim 3 referred to above which was on file on 16th January 2007 for US Application Number 11/427,640 is reproduced in the following text (which includes claims 1 to 3 then on file):

> 1. A display device for video holography, in which the device enables a holographic reconstruction of a three dimensional scene to be generated; the device including a light source and an optical system to illuminate a hologram-bearing medium encoded with a hologram; wherein the size of the reconstructed three dimensional scene is a function of the size of the hologram-bearing medium and the reconstructed three dimensional scene can be anywhere within a volume defined by the hologram-bearing medium and a virtual observer window through which the reconstructed three dimensional scene must be viewed.

2. The device of Claim 1 in which the observer window is placed at the image plane of the light source.

3. The device of Claim 1 in which the hologram comprises a region with information needed to reconstruct a single point in the three dimensional scene, the point being visible from a defined viewing position, and is characterized in that: the region (a) encodes information for that single point in the reconstructed three dimensional scene and (b) is the only region in the hologram encoded with information for that point, and (c) is restricted in size to form a portion of the entire hologram, the size being such that multiple reconstructions of that point caused by higher diffraction orders are not visible at the defined viewing position.

Summary

Therefore in view of the foregoing amendments and remarks, applicant respectfully requests entry of the amendments, favorable reconsideration of the application, withdrawal of all rejections and objections and that claims 11-50 be allowed at an early date and the patent allowed to issue.

Respectfully submitted,

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Appendix A: Clean version of claims 11 and 41 for convenience

Claim 11 (Clean Version): A method for reconstructing a three-dimensional scene using a reconstruction device including a light source, an optical system and a hologram encoded on a hologram-bearing medium having a matrix of cells; the hologram-bearing medium and optical system being illuminated by the light source; the method comprising the steps of:

(i) the optical system generating a Fourier or inverse Fourier transform of the hologram encoded on the hologram-bearing medium at the image plane of the light source;

(ii) providing a viewing window in the image plane of the light source, the viewing window being the location where an observer places at least one eye to view the holographic reconstruction representing the three-dimensional scene, the size of the viewing window being no larger than a single diffraction order of the light diffracted by the hologram-bearing medium;

(iii) encoding the hologram on the hologram-bearing medium to reconstruct a given object point, when seen from the viewing window, in only a limited region of the hologram-bearing medium, so that the Fourier or inverse Fourier transform in the viewing window is restricted to a single diffraction order of the light diffracted by the hologram-bearing medium; and

(iv) forming the holographic reconstruction of the three-dimensional scene within a reconstruction frustum stretching between the hologram-bearing medium and the viewing window.

Claim 41. (Clean version) A reconstruction device for reconstructing a three-dimensional scene including a light source, an optical system and a hologram encoded on a hologram-bearing medium having a matrix of cells; the hologram-bearing medium and optical system being illuminated by the light source; in which:

(i) the optical system generates a Fourier or inverse Fourier transform of the hologram encoded on the hologram-bearing medium at the image plane of the light source;

(ii) the hologram encoded on the hologram-bearing medium to reconstruct a given object point, when seen from a viewing window, which is in the image plane of the light source and is where an observer places at least one eye to view the holographic reconstruction representing a three-dimensional scene, is encoded in only a limited region of the hologram-bearing medium, so that the Fourier or inverse Fourier transform at the viewing window is restricted to a single diffraction order of the light diffracted by the hologram-bearing medium; and

(iii) the device forms the holographic reconstruction within a reconstruction frustum stretching between the hologram-bearing medium and the viewing window.